Report for 2002ND16B: Variables Influencing Habitat Use by Diving Waterbirds Foraging in the Prairie Pothole Region

- Dissertations:
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Report Follows:

Variables Influencing Habitat Use by Diving Waterbirds Foraging in the Prairie Pothole Region

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Abstract
The purpose of this study is to uncover patterns of habitat use by diving waterbirds foraging within potholes in relationship to water depth, submergent vegetation, benthic invertebrate biomass and size, and benthic compactness and particle size. The study will focus on habitat use on the scale of the individual pothole and will seek to explain observed patterns in habitat use by comparing habitat variables to morphological features of diving waterfowl species. Habitat use information can lead to a better understanding of the habitat needs of diving ducks and how to best manage aquatic habitats for these species.

Description of the Regional Water Problem
The site of the research is the prairie pothole region near Minnedosa, Manitoba, Canada, an area drastically modified for agricultural purposes. The prairie pothole region is an important breeding area for waterfowl. While destruction of nesting cover is an obvious adversity to upland nesters (i.e. all dabbling waterfowl), agriculture could also adversely affect the prairie potholes themselves, the foraging habitat of waterfowl. Breeding waterfowl species have similar nutrient requirements, however each species has specific habitat and invertebrate preferences. Inputs such as nutrient-loading and sedimentation could change the pothole habitat, the invertebrate community, and therefore the waterfowl community within these wetlands. This study will investigate the structure of the diving duck guild within potholes in relationship to habitat variables such as submergent vegetation structure, water depth, benthic particle size, and sediment compactness. Since diving ducks forage on benthic prey, sedimentation may be an important influence on the structure of the diving duck guild.

Literature Summary
The northern prairies, extending from north-central Iowa to central Alberta (Euliss et al. 1999), are important for breeding waterfowl of North America, by some estimates producing 50-80% of the continent's duck population (van der Valk 1989). While the whole of the prairie pothole region experiences a climate and hydrologic regime unique in the continent, the hydrology of the prairie pothole region itself is spatially variable, in part due to a precipitation gradient in a north-to-south and west-to-east direction (Euliss et al. 1999). Habitat heterogeneity exists within geographic sub-regions and on a much

smaller scale such as a singular pothole. For example, potholes within the aspen-parkland region can vary from large, open, and permanent wetlands, to those that are small, vegetated, and intermittent. Also, the habitat structure, especially vegetation, typically changes within one pothole from the edges to the center (Stewart and Kantrud 1971).

Prairie-breeding ducks meet their nutritional needs by foraging in the potholes that characterize this region. Breeders have similar dietary needs, and forage mainly on invertebrates (Krapu and Reinecke 1992). However, prey preference varies with each species and sex (Bartonek and Hickey 1969; Siegfried 1973). Diving ducks forage within the wetland bottoms, and thus benthic structure may influence the structure of the diving duck community.

Habitat variables can influence the structure of the invertebrate community upon which waterfowl depend. For example, Topping (1971) found that larval abundance of the invertebrate *Chironomus tentans* larvae was significantly correlated with both organic carbon content and mud particle size in the 0.59-0.83 millimeter particle range. Also, invertebrates in beaver ponds tend to be distributed based on substrate type (Hodlinson 1975). In another study, chironomid densities were significantly correlated with sediment organic content as opposed to invertebrate food supply and predation (Moss and Timms 1989). Therefore, foraging ducks may use one benthic habitat over another because of the prey that habitat promotes.

Benthic conditions may also affect foraging of diving waterbirds directly by affecting accessibility to food given each species' bill behavior and morphology. To illustrate, Gerritsen and van Heezik (1985) found that three species of sandpipers prefer to forage in mud or sand as opposed to pebbles in spite of equal prey densities. They also found that sandpiper-hunting technique (tactile versus visual) varied with substrate type. By altering substrate compactness and hence, penetrability, Myers, Williams, and Pitelka (1980) found that while controlling for prey density, handling time by shorebirds varied inversely with substrate penetrability. Therefore, an environment may have an abundance of a diving duck's preferred prey but may not be conducive the bird to accessing that prey. Osnas (1998) found that diving duck communities were less evenly distributed than expected in the Minnedosa area and suggests a correlation between bill morphology and wetland characteristics is possible.

Diving ducks strain food particles with lamellae, but they also have to expunge the non-food particles associated with their invertebrate prey from their bills. Kooloos et al. (1989) has shown that dabblers have the ability to manipulate the pore size between lamellae given different food particle sizes. Other important bill morphology factors are bill volume and gape. If ducks have difficulty separating prey and detritus particles of similar sizes, detritus particle size may limit where a particular species forages. Particles large enough to enter the mouth but too small to exit through lamellar spaces may decrease the foraging ability of benthic filterers. If probers do not draw in as much non-food material as do filterers, then detritus may not as greatly affect them. Lamellar pore size may not be as plastic in divers, and Langerquist and Ankney (1988) suggest that bill size and shape may be more important in distinguishing between diving duck species.

Differences in substrate softness and texture are related to particle size and shape (e.g. sand, loam, silt, clay) and the size of the capillary pore spaces between soil particles. Substrates can range from loose sandy soils to tight clay bottoms. Loam substrates are those comprised of more or less equal amounts of sand, silt, and clay. The presence of organic matter can give sandy or clay soils the intermediate capillary qualities of loam substrates (Kramer 1983). Subsequent wet/dry cycles may also affect the compactness of wetland soils.

Agricultural practices may also affect substrate structure by increasing the rates of soil erosion and nutrient loading. As little as 0.25 centimeter of sedimentation can significantly reduce macrophyte germination in potholes (Jurik 1994, Wang 1994). Other studies also support this. In Michigan, large sediment loads significantly reduced total seed density as compared to low sediment loads (Dittmar and Neely 1999). In a study of South Dakota potholes, wetlands with cultivated catchments had higher accumulation rates of phosphorous and clay particles as compared to wetlands surrounded by grassland (Martin and Hartman 1987). Freeland, Richardson, and Foss (1999) found similar results in North Dakota wetlands. This increased sedimentation and nutrient-loading rate can be detrimental to the invertebrate community. North Dakota wetlands surrounded by agriculture were found to have reduced invertebrate complexity (Euliss and Mushet 1999). Lindemenan and Clark (1999) studied habitat use by Lesser Scaup in Saskatchewan wetlands. They found wetlands with high scores of human-induced marginal impacts had reduced amphipod and Lesser Scaup abundance. They attributed this to increased sedimentation and turbidity to negatively affects on amphipods and destruction of nesting cover.

Submergent vegetation structure is important to waterfowl as a food source (Canvasbacks eat Sago Pondweed tubers) and for its association with invertebrates. Ducks can show preference for a particular form of vegetation structure based on what invertebrates the vegetation harbors. For example, Armstrong and Nudds (1985) showed that dabbling duck species demonstrate habitat preference on the basis of vegetation structure; each species has a specific prey size preference, and each invertebrate size class is associated with a specific vegetation structure**.** Osnas (1998) found that some diving duck species such as the Canvasbacks are associated with submergent vegetation while other species such as Redheads are associated with bare sediments. Since vegetation is associated with depth, observed patterns of diving bird use by depth may be associated with changing vegetation structure within ponds.

The effects of substrate, detritus, and vegetation are not mutually exclusive. Vegetation structure is dependent benthic conditions. For example, emergent roots may not be able to penetrate harder clay soils or obtain a firm root grasp in softer substrates (Kramer 1983). Wisner (1991) found that in the presence of wave exposure, substrate softness varied inversely with organic content and the water depth of emergent vegetation. Vegetation may also stabilize benthic sediments, therefore decreasing turbidity. Also, potholes may fluctuate between macrophyte and algal dominated equilibrium states (Sandilands et al. 2000, Hargeby et al. 1994). Ultimately, these habitat variables may be controlled by subsequent wet/dry cycles.

Land-use practices can alter the physical conditions within potholes. Forty percent of the original wetlands of prairie Canada were lost due to agriculture and development (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1986), and agriculture still affects many remaining wetlands. Tillage of wetland basins has severely reduced invertebrate populations (Krapu and Reinecke 1992). This practice rids the soil of macrophytes and organic matter, reducing macroinvertebrate numbers when reflooding occurs (Swanson et al 1974). Even if a basin is not tilled, many times agricultural practices damage the wetland catchments, increasing sedimentation (Martin and Hartman 1986; Gleason and Euliss; _____ 1998).

Nudds (1992) suggests that studying waterfowl from the perspective of the ecosystem and community can give insight to management goals addressing problems currently faced by waterfowl. Thus, questions concerning associations between variables in wetland habitats and waterfowl use are of interest for several reasons. First, this research can aid in answering questions related to whether waterfowl distribution is habitat-based or structured by competition. If the structure of the diving bird community is dependent upon habitat variability as opposed to competition, then management efforts can be directed towards increasing the variability of waterfowl habitat instead of eliminating competitors. Habitat variables can also aid in constructing models that predict habitat suitability for waterfowl (Bailey 1981). For example, researching what habitat values are most important in structuring communities and how degradation affects these values can shed light on the causes of population declines such as the declining trend in the population of Lesser Scaup and may aid in reversing this trend. Species may cue in on different habitat variables when using habitats for foraging. These variables are ultimately related to a process (i.e. the need to acquire nutrients provided by a specific prey species) that this study does not directly address. However, correlations between habitat use and habitat variables can give researchers tools to infer why species use one habitat and not another.

Scope and Objectives of Proposed Research

The purpose of this study is to uncover patterns of habitat use by diving waterbirds foraging within potholes in relationship to water depth, submergent vegetation, benthic invertebrate biomass and size, and benthic compactness and particle size. The study will focus on habitat use on the scale of the individual pothole and will seek to explain observed patterns in habitat use by comparing habitat variables to morphological features of diving waterfowl species. The information collected pertaining to foraging depth will be compared to the work of Nelson (1983). Habitat use information can lead to a better understanding of the habitat needs of diving ducks and how to best manage aquatic habitats for these species.

Methods, Procedures, and Facilities

Observations

Observations of foraging diving ducks will be performed on seven study potholes. To minimize disturbance, observations are performed from blinds entered before sunrise. At every half hour for four hours all bird species on the pond are located and their activity recorded. Only duck observations of birds foraging by diving are considered for my thesis, however. To locate the ducks more precisely, a 10 X 10 meter grid structure comprised of color-coded stakes and bobbers is used. The observer uses a pothole map to record observations. These maps are also used to map out the emergent vegetation coverage.

Habitat Sampling

While setting up each pothole depth was recorded at each 10 X 10 meter point. The four corners of each 'quadrant' were averaged to get an average depth for each quadrant. A gauge was placed in each wetland so depth could be recorded for each quadrant during each observation. I sample potholes using the dive locations collected from observations during two sampling periods. The following variables are measured: depth, submergent vegetation structure, sediment compactness, and sediment particle size. Benthic invertebrates are also collected. Submerged vegetation is measured by dragging a 14-pronged garden rake one meter across the bottom two times. Sediment compactness, particle size, and invertebrate information is gathered by means of a 10 centimeter core sample. The sample is taken by placing a clear, a removable plastic insert into a core sampler. These samples can then be capped and allowed to settle. Compactness is measured in the field by using a penetrometer and in the lab by calculating bulk density. The core sample is run through a series of sieves ranging from 19 millimeters to 0.045 millimeters for particle size analysis. Particles from size 19 mm to 0.5 mm are then preserved in 70% ethanol and picked through for invertebrates. Particles from size 0.5 to 0.045 mm are frozen. Invertebrates are identified and measured for lengths under a dissecting microscope. These measurements can be used in regression equations to estimate biomass.

Statistical Analysis

Indirect and direct gradient analysis will be used to explore correlations among habitat variables, and between these environmental variables and habitat use by different waterfowl species.

Anticipated Results and Benefits of the Proposed Study

The habitats used by each species of diving duck within potholes will be characterized. This information can prove useful to managers of waterfowl production areas. Uncovering habitat use patterns in declining species such as the Lesser Scaup may help researchers understand the reason for their decline.

Summary of Results

What circumstances allow coexistence of similar species is a common but complex question in community ecology research. Sympatric species within the same guild must employ a mechanism of niche diversification in order to coexist. Niche separation may result from active competition when one species exploits or interferes with another's ability to use resources. Conversely, if species employ a resource partitioning mechanism based on differential use of habitat, the structure of a guild may depend upon spatial heterogeneity. This would reduce the influence of competition.

I studied the guild structure of foraging diving ducks on the pothole scale in southwestern Manitoba. The goals of my study were to uncover patterns of habitat use by diving ducks foraging within potholes in relationship to water depth, submergent vegetation, benthic invertebrate biomass, abundance, and size, and benthic substrate compactness and particle size and, I also sought to explain observed patterns in habitat use by comparing habitat variables to morphological features of diving waterfowl species. I found that benthic particle size and compactness decrease with depth, and submergent plants tend to grow within certain depth zones. I found that while diving ducks forage at specific depths within potholes, most divers foraged shallowly. Because most divers forage shallowly, variation in dive locations cannot be explained by habitat variables measured, nor by invertebrate biomass, abundance, or size. However, depths where divers forage within potholes can change between years. When food resources are limiting, competition may be high at shallower depths, but diving ducks most likely forage opportunistically on patchily distributed invertebrate prey.